



**THURBER** ENGINEERING LTD.

**2017 GROUNDWATER MONITORING  
VILLAGE OF BAWLF WASTEWATER SEWAGE  
LAGOON**

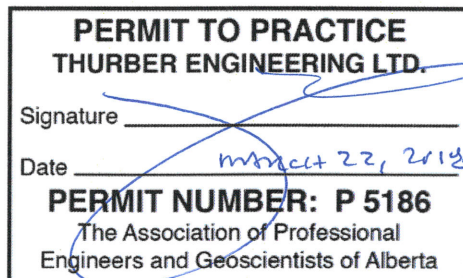
**Report**

to

**Village of Bawlf**

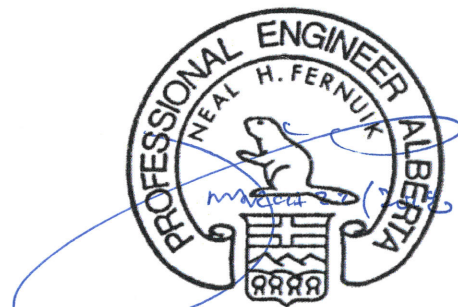


Milan Butorac, P. Geo.  
Hydrogeologist



Date: March 22, 2018

File: 16080



Neal Fernuk, M. Sc., P. Eng.  
Review Principal





## TABLE OF CONTENTS

1.	INTRODUCTION.....	1
2.	SCOPE OF WORK.....	1
3.	SITE DESCRIPTION.....	1
4.	FIELD INVESTIGATION.....	2
5.	REGULATORY GUIDELINES .....	2
6.	ASSESSMENT.....	2
7.	CONCLUSION .....	4

## STATEMENT OF LIMITATIONS AND CONDITIONS

### APPENDIX A

- Drawings

### APPENDIX B

- Tables

### APPENDIX C

- Well Logs

### APPENDIX D

- Laboratory Analytical Report





## **1. INTRODUCTION**

At the request of the Village of Bawlf, Thurber Engineering Ltd. conducted a 2017 groundwater monitoring program at their wastewater lagoon located within NE ¼ 25-45-18 W4M ("Site") approximately one kilometer southwest of the Village of Bawlf, Alberta.

Authorization to conduct the 2017 groundwater monitoring program was provided by Ms. Tracy M Ormsbee, CAO of the Village of Bawlf.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

## **2. SCOPE OF WORK**

The scope of work, as outlined in Alberta Environment and Parks August 11, 2016, authorization No. 00000400-02-00 was as follows:

- Monitor depth to water in spring and fall of 2017 in five groundwater wells,
- Obtain groundwater samples for chemical analyses in fall of 2017, and
- Submit 2017 report summarizing historical water levels and groundwater chemical analyses for 2016 and 2017.

This report summarizes the water level measurements and water chemistry data collected in 2016 and 2017.

## **3. SITE DESCRIPTION**

A site location map of the wastewater lagoon is shown on Drawing 16080-1 in Appendix A. The wastewater lagoon comprises of two anaerobic cells (cells 1 and 2), primary cell (cell 5) and a secondary cell (cell 6) as shown on Drawing 16080-2 in Appendix A. A deep and shallow pond are located just to the north of the wastewater lagoon. The depths of the cells from top of the berm to the bottom were approximately 4 m for Cells 1 and 2, 2.3 m for Cell 5 and 3 m for Cell 6. The berms slide slopes were inclined at approximately 3H:1V. Along the south berm of the wastewater lagoon there is an unnamed creek where the treated water is discharged once a year.





#### **4. FIELD INVESTIGATION**

The results of water level measurements taken on May 8, 2017, November 21, 2017 and in 2016 from monitoring wells TH15-1 through TH15-5 are presented in Table 1 in Appendix B. Monitoring well completion details are shown in Appendix C.

Water samples for chemical analysis were collected from the monitoring wells using dedicated bailers. Each well was bailed until dry and then were sampled after water recovered sufficiently for sampling. The water samples were analyzed by Exova for the following chemical analyses;

- Routine Potability Parameters,
- Dissolved Metals Parameters,
- Total Kjeldahl Nitrogen,
- Chemical Oxygen Demand, and
- Total and Fecal Coliforms.

#### **5. REGULATORY GUIDELINES**

The groundwater analytical data were compared to the Alberta Environment and Parks (AEP), 2016 *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* Commercial and the Health Canada, (2017) *Canadian Drinking Water Quality (CDWQ)* guidelines.

#### **6. ASSESSMENT**

Depth to groundwater ranged from 1.77 m below ground surface (bgs) to 2.72 m bgs in May 2017 and between 2.02 m bgs to 2.56 m bgs in November 2017, as summarized in Table 1 in Appendix B. A groundwater table contour map of the November 21, 2017 groundwater levels measurements is shown on Drawing 16080-2 in Appendix A. The direction of groundwater flow is predominantly North-Northwest and is similar to the 2016 flow direction.

Table 2 in Appendix B summarizes the results the groundwater chemical analyses performed by Exova on the November 2017 groundwater samples. Details of the chemical analyses as provided by Exova are in Appendix D. Sulphate, Manganese, sodium and Total Dissolved Solids (TDS) do not meet AEP Tier 1 guidelines in both 2016 and 2017 sampling events. Iron did not meet AEP guidelines in well TH15-5 in the 2016 sampling event and cadmium met in all wells in 2017 but not in 2016. Uranium did not meet AEP guidelines in wells TH15-1 through





TH15-3 in 2016 and 2017 but did in both years in wells TH15-4 and TH15-5. The uranium duplicate sample in TH15-5 in 2016 did not meet AEP guidelines.

Absence of fecal coliforms and total coliforms in the samples taken in November 2017 from monitoring wells indicates that there is no microbiological impact of water from lagoon at surrounding area. Presence of total coliforms in samples taken in January 2016 shows the contamination caused by drilling completed just month and a half before in the December 2015. Total coliforms analysis shows that waters collected in the lagoon cells are more than a million CFU/100ml while water collected in 2016 from monitoring wells shows total coliforms in range from less than detection CFU/100ml to 7000 CFU/100ml. The Health Canada guideline for total coliforms is less than detection CFU/100ml.

The analyses also show that lagoon water has significantly less TDS content. Most of other chemical parameters are distinctively different for water in lagoon and groundwater in the monitoring wells. The largest difference of waters in lagoon and groundwater sampled in monitoring wells is with regards to calcium and sulfate. Concentrations of calcium and sulfate is approximately 10 times higher in groundwater and has not changed or is slightly increasing in the wells when comparing samples between 2016 and 2017. Total hardness in samples from monitoring wells is also without change and it is also approximately 10 times higher than hardness of water in lagoon.

Stable content of calcium, sulfate, other major elements, hardness and other measured parameters of water in monitoring wells indicate that water from lagoon has not interfered with groundwater quality in surrounding area.

As part of Thurber's quality assurance/ quality control (QA/QC) a duplicate groundwater sample was analyzed. Table 3 in Appendix B summarizes the relative percent differences (RPD) between sample TH15-5 and its associated duplicate TH15-5\_Dupl. Samples with constituents below method detection limits cannot be compared for RPDs. The results show RPDs of less than 20 percent for most analytes and is considered acceptable for field groundwater duplicates. Calcium, Sulphate, TDS and Hardness are primary constituents of concern and these analytes had maximum RPDs of 2%. The analytes with the highest RPD values were Arsenic (67%), Nickel (60%), Zinc (56%), Total Ammonia (59%), Dissolved Nitrate, and Dissolved Chloride (123% RPD), from the TH15-5\_Dupl and did not affect the interpretation.





## **7. CONCLUSION**

The measurements and tests indicate that water from the lagoon is infiltrating at a very slow rate in a lateral and downward direction from the lagoon but is not leaking via a preferential pathway and has not changed the groundwater quality.

Thurber recommends a continuation of monitoring water levels twice a year and water chemistry annually.



## STATEMENT OF LIMITATIONS AND CONDITIONS

### 1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

### 2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

### 3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

### 4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

### 5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

### 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

### 7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

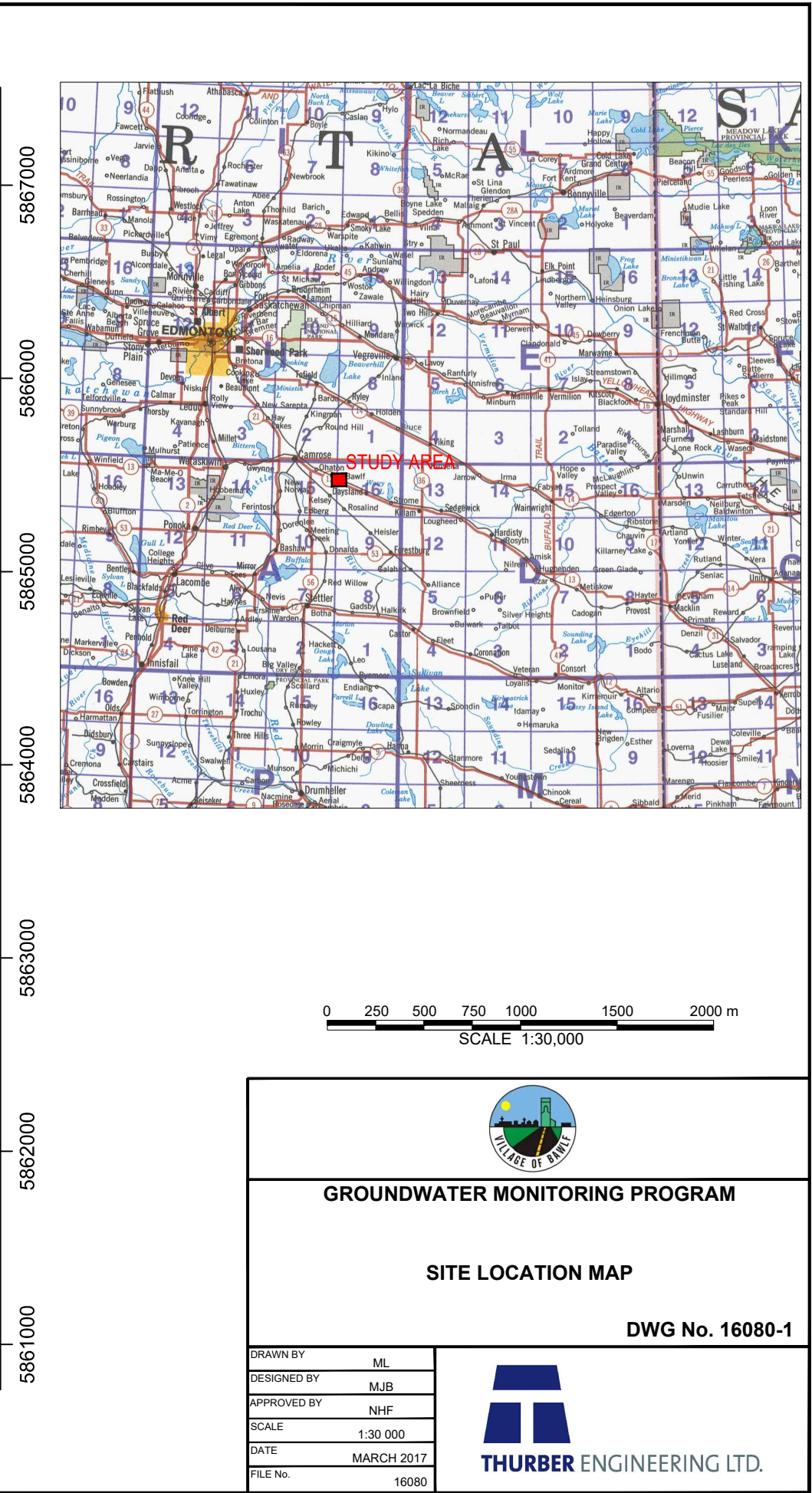
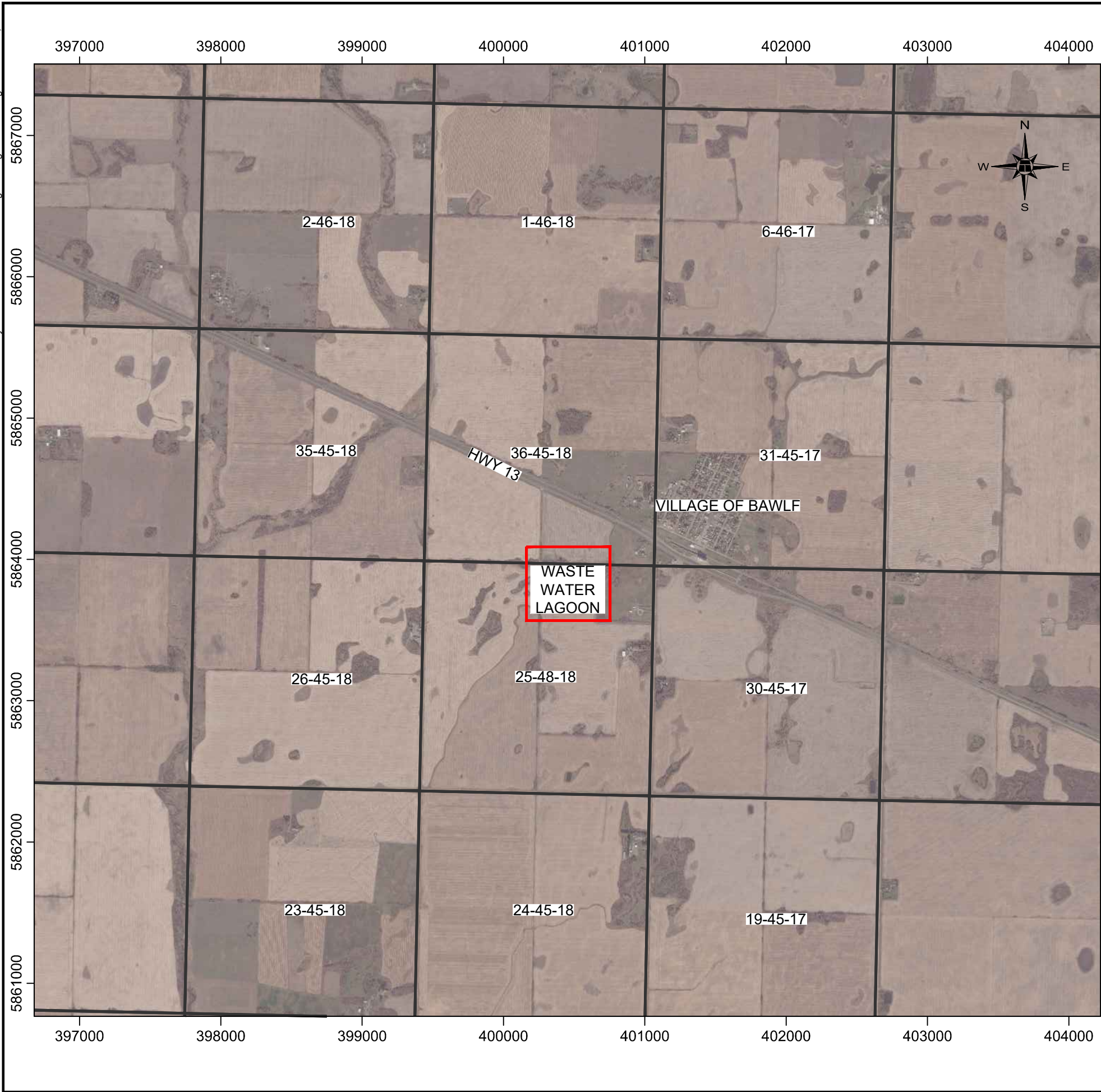




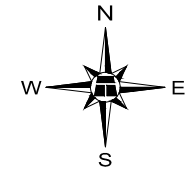
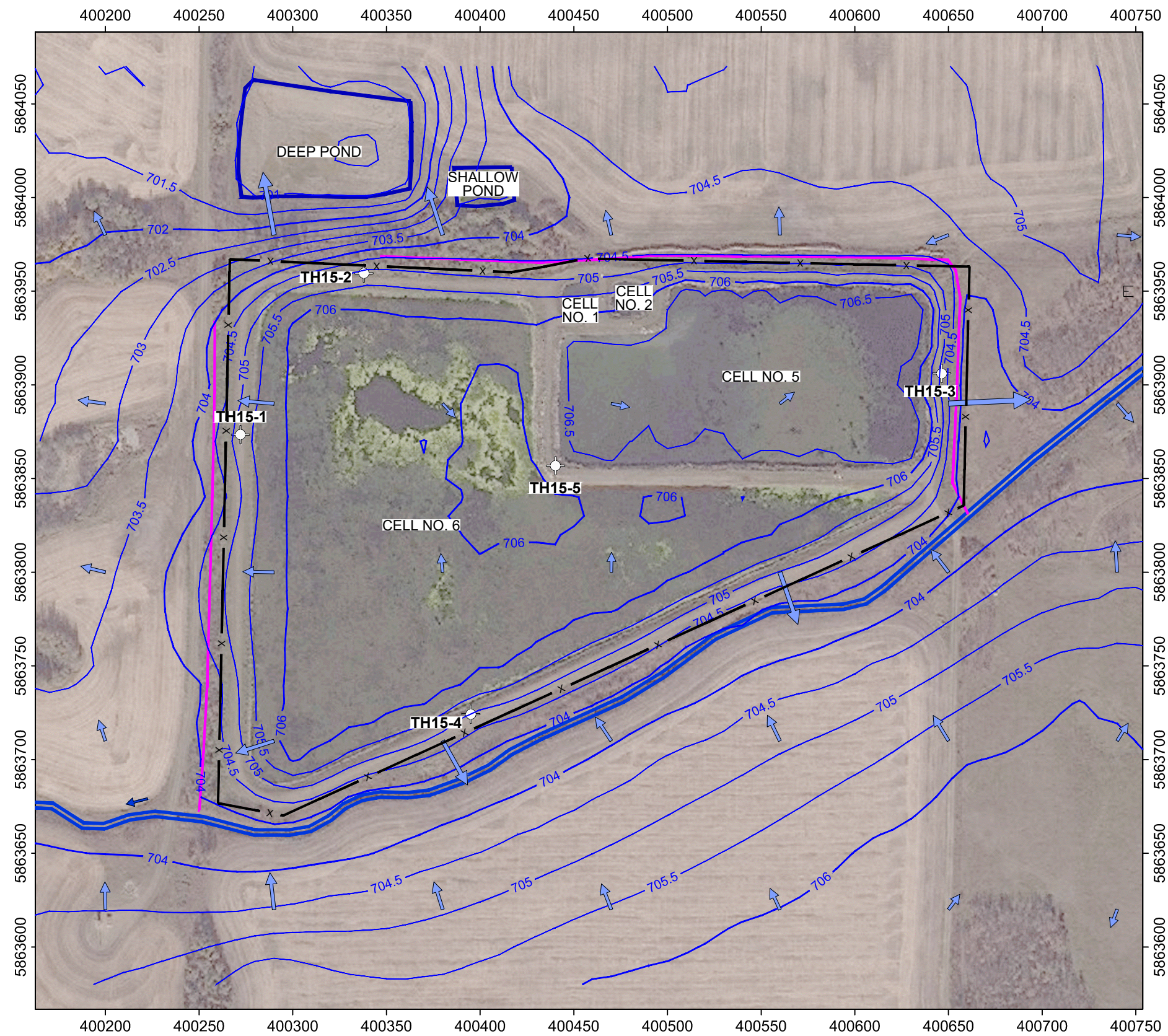
## **APPENDIX A**

Drawings



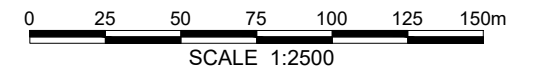






LEGEND

- CREEK
- TRENCH
- FENCE
- 2015 MONITORING WELLS
- WATER TABLE CONTOUR (CONTOUR INTERVAL = 0.5m)
- WATER TABLE SLOPE DIRECTION



GROUNDWATER MONITORING PROGRAM

LAGOON MAP

DWG No. 16080-2

DRAWN BY	KLW
DESIGNED BY	MJB
APPROVED BY	NHF
SCALE	1:2500
DATE	DECEMBER 2017
FILE No.	16080







## **APPENDIX B**

Tables





# TABLE 1 - GROUNDWATER MONITORING RESULTS: SUMMARY

2017 GROUNDWATER MONITORING PROGRAM

VILLAGE OF BAWLF

Monitoring Location	Monitoring Date	Well Construction					Comments
		Ground Surface Elevation	Casing Elevation	Depth to Water	Depth to Water	Calculated Groundwater Elevation	
		(m asl)	(m asl)	(m btoc)	(m bgs)	(m asl)	
TH15-1	11-Jan-16	707.56	708.40	5.35	4.51	703.05	
TH15-1	23-Nov-16	707.56	708.40	3.29	2.45	705.11	
TH15-1	8-May-17	707.56	708.40	2.97	2.13	705.43	
TH15-1	21-Nov-17	707.56	708.40	3.11	2.27	705.29	
TH15-2	11-Jan-16	707.65	708.49	3.06	2.22	705.43	
TH15-2	23-Nov-16	707.65	708.49	3.34	2.50	705.15	
TH15-2	8-May-17	707.65	708.49	2.68	1.84	705.81	
TH15-2	21-Nov-17	707.65	708.49	3.31	2.47	705.18	
TH15-3	11-Jan-16	707.34	708.10	3.10	2.34	705.00	
TH15-3	23-Nov-16	707.34	708.10	2.56	1.80	705.54	
TH15-3	8-May-17	707.34	708.10	2.87	2.11	705.23	
TH15-3	21-Nov-17	707.34	708.10	2.78	2.02	705.32	
TH15-4	11-Jan-16	707.42	708.24	2.82	2.00	705.42	
TH15-4	23-Nov-16	707.42	708.24	3.21	2.39	705.03	
TH15-4	8-May-17	707.42	708.24	2.59	1.77	705.65	
TH15-4	21-Nov-17	707.42	708.24	3.38	2.56	704.86	
TH15-5	11-Jan-16	707.93	708.74	7.25	6.44	701.49	
TH15-5	23-Nov-16	707.93	708.74	1.64	0.83	707.10	
TH15-5	8-May-17	707.93	708.74	3.53	2.72	705.21	
TH15-5	21-Nov-17	707.93	708.74	3.08	2.27	705.66	

Notes:

- Parameter not measured or not applicable.
- m btoc Depth measured in metres below top of casing (btoc).
- m bgs Depth measured in metres below ground surface (bgs).
- m asl Elevation in metres above mean sea level.



TABLE 2 - GROUNDWATER MONITORING RESULTS: SUMMARY  
2017 GROUNDWATER MONITORING PROGRAM  
VILLAGE OF BAWLF

Sample Information			Routine Potability Parameters																				Dissolved Metals Parameters																Microbiological Analysis				
Sample Location	Sample Date		pH	Electrical Conductivity	Hydroxide	Bicarbonate	Carbonate	Chloride	Fluoride	Nitrate and Nitrite (as N)	Nitrate (as N)	Nitrite (as N)	Sulphate	Calcium	Iron	Magnesium	Manganese	Potassium	Sodium	Total Dissolved Solids	Total Alkalinity (as CaCO <sub>3</sub> )	Total Hardness (as CaCO <sub>3</sub> )	Chemical Oxygen Demand	Kjeldahl Nitrogen	Aluminum	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Silver	Uranium	Zinc	Fecal Coliforms	Total Coliforms			
			(dS/m)	(µS/cm)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	MPN/100ml	Membrane Filtration (CFU/100ml)		
Alberta Tier 1 - Industrial Land Use <sup>1</sup>			6.5-8.5	---	---	---	---	250	1.5	---	10	1.0	500	---	0.3	---	0.05	---	200	500	---	---	---	---	---	---	0.006	0.01	1	5	0.005	---	1	0.01	---	0.01	---	0.01	---	0.02	5	0 <sup>2</sup>	0 <sup>2</sup>
Site Upper Unit	TH15-1	14-Jan-16	7.78	5,080	<5	387	<6	23	---	<0.07	<0.05	<0.025	2,920	446	<0.05	137	1	16	905	4,640	317	1,680	193	2.97	0.051	<0.001	0.0004	0.0004	0.190	0.19000	<0.002	0.006	<0.0005	0.0190	0.001	<0.00005	0.032	0.020	<1.8	7000			
	TH15-1	21-Nov-17	7.74	5,560	<5	529	<6	19	---	0.08	<0.02	0.080	3,170	408	<0.05	137	1	15	1,010	5,020	433	1,580	75	1.40	<0.010	<0.001	0.0020	0.0240	0.232	0.00008	<0.002	<0.005	<0.0005	0.0130	<0.001	<0.00005	0.026	<0.005	<1	1			
	TH15-2	14-Jan-16	7.39	3,630	<5	1,010	<6	20	---	<0.07	<0.05	<0.025	1,620	499	<0.02	112	4	14	412	3,170	829	1,710	308	2.74	0.009	<0.0004	0.0004	0.0004	0.225	0.19000	<0.001	0.002	0.0004	0.0318	0.0005	<0.00002	0.021	0.020	<1.8	300			
	TH15-2	21-Nov-17	7.17	3,230	<5	1,010	<6	46	---	0.06	<0.02	0.060	1,240	449	0.07	119	2	13	288	2,660	830	1,610	42	0.59	<0.004	<0.0004	0.0007	0.0470	0.149	0.00041	<0.001	0.002	<0.0002	0.0180	<0.0004	<0.00002	0.036	0.006	<1	<1			
	TH15-3	14-Jan-16	7.63	5,380	<5	1,470	<6	122	---	<0.07	<0.05	<0.025	2,570	750	<0.05	225	2	13	654	5,050	1,200	2,800	96	2.16	<0.01	<0.001	0.0004	0.0004	0.150	0.19000	<0.002	<0.005	<0.0005	0.0360	<0.001	<0.00005	0.103	0.005	<1.8	1300			
	TH15-3	21-Nov-17	7.18	6,040	<5	1,630	<6	113	---	<0.05	<0.02	<0.07	2,890	755	0.20	226	3	14	815	5,610	1,330	2,810	58	1.29	<0.010	<0.001	<0.001	0.0220	0.174	0.00020	<0.002	<0.005	<0.0005	0.0470	<0.001	<0.00005	0.086	<0.005	<1	<1			
	TH15-4	14-Jan-16	7.75	3,230	<5	696	<6	12	---	<0.07	<0.05	<0.025	1,370	226	<0.02	74	2	17	543	2,580	571	869	35	1.56	<0.004	<0.0004	0.0004	0.0004	0.339	0.19000	<0.001	<0.002	<0.0002	0.0062	<0.0004	<0.00002	0.003	0.007	<1.8				
	TH15-4	21-Nov-17	7.58	3,370	<5	709	<6	13	---	<0.05	<0.02	<0.07	1,440	250	0.25	67	2	18	540	2,680	582	899	26	0.95	<0.004	<0.0004	0.0078	0.0360	0.393	0.00002	<0.001	<0.002	<0.0002	0.0068	<0.0004	<0.00002	0.005	0.004	<1	<1			
	TH15-5	14-Jan-16	7.75	8,330	<5	649	<6	9	---	<0.07	<0.05	<0.025	4,790	440	2.28	136	0	18	1,940	7,660	532	1,660	59	3.89	<0.01	<0.001	0.0004	0.0004	0.524	0.19000	<0.002	<0.005	<0.0005	0.0030	<0.001	<0.00005	0.003	0.010	<1.8				
	TH15-5	21-Nov-17	7.97	9,110	<5	630	<6	9	---	1.91	<0.05	1.910	5,240	456	<0.05	144	0	19	1,970	8,150	516	1,730	34	0.42	<0.010	<0.001	0.0020	0.0070	0.618	0.00008	<0.002	<0.005	<0.0005	0.0040	<0.001	<0.00005	0.004	0.023	<1	<1			
TH15-5_Dupl	14-Jan-16	7.45	5,280	<5	1,470	<6	121	---	<0.07	<0.05	<0.025	2,550	739	<0.05	222	2	13	648	5,010	1,210	2,760	100	2.67	<0.01	<0.001	0.0004	0.0004	0.160	0.19000	<0.002	<0.005	<0.0005	0.0370	<0.001	<0.00005	0.097	0.006	<1.8	900				
TH15-5_Dupl	21-Nov-17	7.62	9,120	<5	658	<6	38	---	1.04	<0.05	1.040	5,340	464	0.07	147	0	20	1,990	8,320	539	1,760	40	1.94	<0.010	<0.001	0.0040	0.0060	0.614	<0.00005	<0.002	<0.005	<0.0005	0.0074	<0.001	<0.00005	0.004	0.013	<1	<1				

<sup>1</sup>Alberta Environment and Parks (AEP). Alberta Tier 1 Soil and Groundwater Remediation Guidelines for Industrial Land Use based on Fine-Grained Soils. 2016.

<sup>2</sup>Guideline: Health Canada GCDWQ. Guidelines for Canadian Drinking Water Quality. Health Canada. February 2017.

---	Parameter not analyzed or no guideline.
2920	Parameter concentration does not meet Industrial guidelines.
7000	Parameter concentration does not meet Health Canada guidelines.



**TABLE 3 - GROUNDWATER SAMPLE RELATIVE PERCENT DIFFERENCE (RPD)  
2017 GROUNDWATER MONITORING PROGRAM  
VILLAGE OF BAWLF**

<b>Analysis</b>	<b>Well</b>	<b>TH15-5 (21-Nov-17)</b>	<b>TH15-5_Dupl (21-Nov-17)</b>	<b>RPD</b>
<b>Low Level Elements</b>	<b>Units</b>			
Dissolved Cadmium (Cd)	ug/L	0.00008	<0.00005	N/C <sup>1</sup>
<b>Dissolved Elements</b>				
Aluminum (Al)	mg/L	<0.010	<0.010	N/C
Antimony (Sb)	mg/L	<0.001	<0.001	N/C
Arsenic (As)	mg/L	0.002	0.004	67%
Barium (Ba)	mg/L	0.007	0.006	15%
Beryllium (Be)	mg/L	<0.0005	<0.0005	N/C
Boron (B)	mg/L	0.618	0.614	1%
Calcium (Ca)	mg/L	456	464	2%
Chromium (Cr)	mg/L	<0.002	<0.002	N/C
Cobalt (Co)	mg/L	<0.0005	<0.0005	N/C
Copper (Cu)	mg/L	<0.005	<0.005	N/C
Iron (Fe)	mg/L	<0.05	0.07	N/C
Lead (Pb)	mg/L	<0.0005	<0.0005	N/C
Lithium (Li)	mg/L	0.749	0.76	1%
Magnesium (Mg)	mg/L	144	147	2%
Manganese (Mn)	mg/L	0.29	0.3	3%
Molybdenum (Mo)	mg/L	<0.005	<0.005	N/C
Nickel (Ni)	mg/L	0.004	0.0074	60%
Potassium (K)	mg/L	19	20	5%
Selenium (Se)	mg/L	<0.001	<0.00020	N/C
Silicon (Si)	mg/L	10.0	10.0	0%
Silver (Ag)	mg/L	10.0	10.0	0%
Sodium (Na)	mg/L	1970	1990	1%
Strontium (Sr)	mg/L	7.14	7.33	3%
Sulphur (S)	mg/L	2.5	2.5	0%
Thallium (Tl)	mg/L	<0.0003	<0.0003	N/C
Tin (Sn)	mg/L	<0.005	<0.005	N/C
Titanium (Ti)	mg/L	<0.002	<0.002	N/C
Uranium (U)	mg/L	0.004	0.004	0%
Vanadium (V)	mg/L	<0.0005	<0.0005	N/C
Zinc (Zn)	mg/L	0.023	0.013	56%
<b>Nutrients</b>				
Total Ammonia (N)	mg/L	1.91	1.04	59%
Total Phosphorus (P)	mg/L			
<b>Calculated Parameters</b>				
Hardness (CaCO3)	mg/L	1730	1760	2%
Ion Balance	N/A	101	100	1%
Dissolved Nitrate (NO3)	mg/L	1.91	1.04	59%
Dissolved Nitrite (NO2)	mg/L	<0.05	<0.05	N/C
Total Dissolved Solids	mg/L	8150	8320	2%
<b>Misc. Inorganics</b>				
Conductivity	uS/cm	9110	9120	0%
pH	N/A	7.97	7.62	4%
<b>Anions</b>				
Alkalinity (PP as CaCO3)	mg/L	<5.0	<5.0	N/C
Alkalinity (Total as CaCO3)	mg/L	516	539	4%
Bicarbonate (HCO3)	mg/L	630	658	4%
Carbonate (CO3)	mg/L	<6	<6	N/C
Dissolved Sulphate (SO4)	mg/L	5240	5340	2%
Dissolved Chloride (Cl)	mg/L	9	38	123%
				<b>18%</b>

<sup>1</sup> RPD Not Calculated





## **APPENDIX C**

Well Logs



CLIENT: VILLAGE OF BAWLF	PROJECT: Village of Bawlf Lagoon-Groundwater Assessment-Phase 1	BOREHOLE NO: TH15-1
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 1, 2015	PROJECT NO: 19-6835-1
DRILL/METHOD: Track / Solid Stem Augers	LOCATION: N5863873.46, E400272.04	ELEVATION: 707.56 (m)

# SAMPLE TYPE

BACKFILL TYPE ☒ BENTONITE ☐ SAND ☐ SLOUGH

DEPTH (m)	SAMPLE TYPE	REMARKS	SOIL DESCRIPTION	ELEVATION (m)
0			TOPSOIL, brown, silty clay, roots to 0.1m	
			CLAY (FILL)	
			dark brown, silty, trace topsoil and silt lenses	707
1				706
2				705
3				704
4			CLAY	
			mottled grey - brown, silty, trace silt lenses and gravel	703
5				702
6		Seepage	-grey	701
7			END OF TEST HOLE AT 6.8m	
			UPON COMPLETION: (Below ground surface)	
			-Slough at 6.5m	
			-No water	
			Standpipe piezometer installed	
			WATER LEVEL BELOW GROUND SURFACE:	
			-December 1, 2015 = Dry	
8				699
9				698
10				

BOREHOLE LOG 19-6835-1 GPJ THRB AB GDT 1/25/16- LIBRARY-NEW LOGO - NE GLB



THURBER ENGINEERING LTD.

FIELD LOGGED BY: JLM

PREPARED BY: MJB

REVIEWED BY:

COMPLETION DEPTH: 6.8 m

COMPLETION DATE: 12/1/15

Page 1 of 1



CLIENT: VILLAGE OF BAWLF	PROJECT: Village of Bawlf Lagoon-Groundwater Assessment-Phase 1	BOREHOLE NO: TH15-2
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 1, 2015	PROJECT NO: 19-6835-1
DRILL/METHOD: Track / Solid Stem Augers	LOCATION: N5863959.58, E400337.97	ELEVATION: 707.65 (m)


SAMPLE TYPE

BACKFILL TYPE ☒ BENTONITE ☐ SAND

DEPTH (m)	SAMPLE TYPE	REMARKS	SOIL DESCRIPTION	ELEVATION (m)
0			TOPSOIL, brown, silty clay, roots to 0.2m	
			CLAY (FILL) brown, silty, trace silt lenses and topsoil, occasional gravel	707
-1				706
-2				705
-3				704
			CLAY mottled grey - brown, silty, trace oxides, coal, and gravel	704
-4				703
-5				702
-6		-Seepage	-fine sand lenses	701
-7			END OF TEST HOLE AT 6.8m UPON COMPLETION: (Below ground surface) -No slough -Water at 6.6m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -December 1, 2015 = 6.06m	700
-8				699
-9				698
-10				

BOREHOLE LOG 19-6835-1.GPJ THRB AB GDT 1/25/16- LIBRARY-NEW LOGO - N E GLB



CLIENT: VILLAGE OF BAWLF		PROJECT: Village of Bawlf Lagoon-Groundwater Assessment-Phase 1		BOREHOLE NO: TH15-3	
DRILLING COMPANY: Mobile Augers & Research Ltd.		DATE DRILLED: December 1, 2015		PROJECT NO: 19-6835-1	
DRILL/METHOD: Track / Solid Stem Augers		LOCATION: N5863906.07, E400646.36		ELEVATION: 707.34 (m)	
SAMPLE TYPE					
BACKFILL TYPE <input checked="" type="checkbox"/> BENTONITE <input type="checkbox"/> SAND <input type="checkbox"/> SLOUGH					
DEPTH (m)	SAMPLE TYPE	REMARKS		SOIL DESCRIPTION	ELEVATION (m)
0				TOPSOIL, dark brown, silty clay	707
				CLAY (FILL)	
				dark brown, silty, roots, trace topsoil and gravel	
-1					706
-2					705
-3		-Seepage		CLAY	704
				mottled grey - brown, silty, trace gravel and silt lenses	
-4					703
				-brown, sandy	
-5					702
-6				END OF TEST HOLE AT 5.3m	
				UPON COMPLETION: (Below ground surface)	
				-Slough at 3.8m	
				-Water at 4.4m	
				Standpipe piezometer installed	
				WATER LEVEL BELOW GROUND SURFACE:	701
				-December 1, 2015 = 2.79m	
-7					700
-8					699
-9					698
-10					
 THURBER ENGINEERING LTD.			FIELD LOGGED BY: JLM PREPARED BY: MJB REVIEWED BY:		COMPLETION DEPTH: 5.3 m COMPLETION DATE: 12/1/15



CLIENT: VILLAGE OF BAWLF		PROJECT: Village of Bawlf Lagoon-Groundwater Assessment-Phase 1		BOREHOLE NO: TH15-4	
DRILLING COMPANY: Mobile Augers & Research Ltd.		DATE DRILLED: December 1, 2015		PROJECT NO: 19-6835-1	
DRILL/METHOD: Track / Solid Stem Augers		LOCATION: N5863724.27, E400395.03		ELEVATION: 707.42 (m)	
SAMPLE TYPE					
BACKFILL TYPE <input checked="" type="checkbox"/> BENTONITE <input type="checkbox"/> SAND <input type="checkbox"/> SLOUGH					
DEPTH (m)	SAMPLE TYPE	REMARKS		SOIL DESCRIPTION	ELEVATION (m)
0				TOPSOIL, brown, silty clay	707
				CLAY (FILL) dark brown, silty, trace topsoil and gravel	706
1					705
2					704
3				CLAY mottled grey - brown, silty, trace gravel, silt lenses, oxides, and gypsum	703
4					702
5				-silt lenses	701
6				-grey	700
7				END OF TEST HOLE AT 6.8m UPON COMPLETION: (Below ground surface) -Slough at 6.5m -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -December 1, 2015 = 3.26m	699
8					698
9					
10					

BOREHOLE LOG 19-6835-1.GPJ THRB AB.GDT 1/25/16- LIBRARY-NEW LOGO - N E GLB



THURBER ENGINEERING LTD.

FIELD LOGGED BY: JLM

PREPARED BY: MJB

REVIEWED BY:

COMPLETION DEPTH: 6.8 m


COMPLETION DATE: 12/1/15



CLIENT: VILLAGE OF BAWLF		PROJECT: Village of Bawlf Lagoon-Groundwater Assessment-Phase 1		BOREHOLE NO: TH15-5	
DRILLING COMPANY: Mobile Augers & Research Ltd.		DATE DRILLED: December 1, 2015		PROJECT NO: 19-6835-1	
DRILL/METHOD: Track / Solid Stem Augers		LOCATION: N5863856.88, E400440.19		ELEVATION: 707.93 (m)	
SAMPLE TYPE					
BACKFILL TYPE <input checked="" type="checkbox"/> BENTONITE <input type="checkbox"/> SAND <input type="checkbox"/> SLOUGH					
DEPTH (m)	SAMPLE TYPE	REMARKS		SOIL DESCRIPTION	ELEVATION (m)
0				TOPSOIL, brown, silty clay, roots to 0.2m, occasional gravel	
1				CLAY (FILL) mottled light brown - dark brown, silty, occasional gravel and silt lenses	707
2					706
3				TOPSOIL AND CLAY (FILL), black, occasional gravel	
4				CLAY (FILL) mottled light brown - dark brown, silty, occasional gravel and silt lenses	705
5				-dark brown	704
6		-Seepage		-grey, occasional dark brown, trace gravel and silt lenses	703
7					702
8					701
9				-grey CLAY grey, sandy, trace gravel	700
10					699
					698

BOREHOLE LOG 19-6835-1.GPJ THRB AB.GDT 1/25/16- LIBRARY-NEW LOGO - N.E.GLB



CLIENT: VILLAGE OF BAWLF		PROJECT: Village of Bawlf Lagoon-Groundwater Assessment-Phase 1		BOREHOLE NO: TH15-5	
DRILLING COMPANY: Mobile Augers & Research Ltd.		DATE DRILLED: December 1, 2015		PROJECT NO: 19-6835-1	
DRILL/METHOD: Track / Solid Stem Augers		LOCATION: N5863856.88, E400440.19		ELEVATION: 707.93 (m)	
SAMPLE TYPE					
BACKFILL TYPE <input checked="" type="checkbox"/> BENTONITE <input type="checkbox"/> SAND <input type="checkbox"/> SLOUGH					
DEPTH (m)	SAMPLE TYPE	REMARKS	SLOTTED PIEZOMETER	SOIL DESCRIPTION	ELEVATION (m)
10				CLAY - CONTINUED	
11				END OF TEST HOLE AT 10.7m UPON COMPLETION: (Below ground surface) -Slough at 9.7m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -December 1, 2015 = 9.20m	697
12					696
13					695
14					694
15					693
16					692
17					691
18					690
19					689
20					688
 THURBER ENGINEERING LTD.			FIELD LOGGED BY: JLM PREPARED BY: MJB REVIEWED BY:		COMPLETION DEPTH: 10.7 m COMPLETION DATE: 12/1/15 Page 2 of 2





## **APPENDIX D**

Laboratory Analytical Report



## Report Transmission Cover Page

Bill To: Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID: 16080 Project Name: Bawlf Project Location: LSD: P.O.: 16080 Proj. Acct. code:	Lot ID: <b>1240624</b> Control Number: C110307 Date Received: Nov 21, 2017 Date Reported: Nov 27, 2017 Report Number: 2245158
Attn: Milan Butorac Sampled By: Milan Butorac Company: Thurber Engineering Ltd.		

Contact	Company	Address
<b>Milan Butorac</b>	<b>Thurber Engineering Ltd.</b>	4127 Roper Road Edmonton, AB T6B 3S5 Phone: (780) 438-1460 Fax: (780) 437-7125 Email: <a href="mailto:mbutorac@thurber.ca">mbutorac@thurber.ca</a>

<u>Delivery</u>	<u>Format</u>	<u>Deliverables</u>
Email - Merge Reports	PDF	COC / Test Report
Email - Single Report	PDF	COA
Email - Single Report	Standard Crosstab	Test Report

<b>Sharon Bunn</b>	<b>Thurber Engineering Ltd.</b>	4127 Roper Road Edmonton, AB T6B 3S5 Phone: (780) 438-1460 Fax: (780) 437-7125 Email: <a href="mailto:Sbunn@thurber.ca">Sbunn@thurber.ca</a>
--------------------	---------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------

<u>Delivery</u>	<u>Format</u>	<u>Deliverables</u>
Email - Single Report	PDF	Invoice

### Notes To Clients:

The information contained on this and all other pages transmitted, is intended for the addressee only and is considered confidential.  
If the reader is not the intended recipient, you are hereby notified that any use, dissemination, distribution or copy of this transmission is strictly prohibited.  
If you receive this transmission by error, or if this transmission is not satisfactory, please notify us by telephone.



## Analytical Report

Bill To: Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5 Attn: Milan Butorac Sampled By: Milan Butorac Company: Thurber Engineering Ltd.	Project ID: 16080 Project Name: Bawlf Project Location: LSD: P.O.: 16080 Proj. Acct. code:	Lot ID: <b>1240624</b> Control Number: C110307 Date Received: Nov 21, 2017 Date Reported: Nov 27, 2017 Report Number: 2245158
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------

		Reference Number	1240624-1	1240624-2	1240624-3	
		Sample Date	Nov 21, 2017	Nov 21, 2017	Nov 21, 2017	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH15-1 / 0.1°C	TH15-2 / 0.1°C	TH15-3 / 0.1°C	
		Matrix	Water	Water	Water	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Aggregate Organic Constituents						
Chemical Oxygen Demand		mg/L	75	42	58	5
Inorganic Nonmetallic Parameters						
Kjeldahl Nitrogen	Total	mg/L	1.40	0.59	1.29	0.07
Metals Dissolved						
Silicon	Dissolved	mg/L	7.77	11.4	15.4	0.05
Sulfur	Dissolved	mg/L	1060	415	964	0.3
Aluminum	Dissolved	mg/L	<0.010	<0.004	<0.010	0.002
Antimony	Dissolved	mg/L	<0.001	<0.0004	<0.001	0.0002
Arsenic	Dissolved	mg/L	0.002	0.0007	<0.001	0.0002
Barium	Dissolved	mg/L	0.024	0.047	0.022	0.001
Beryllium	Dissolved	mg/L	<0.0005	<0.0002	<0.0005	0.0001
Bismuth	Dissolved	mg/L	<0.002	<0.001	<0.002	0.0005
Boron	Dissolved	mg/L	0.232	0.149	0.174	0.002
Cadmium	Dissolved	mg/L	0.00008	0.00041	0.0002	0.00001
Chromium	Dissolved	mg/L	<0.002	<0.001	<0.002	0.0005
Cobalt	Dissolved	mg/L	0.003	0.0041	0.0084	0.0001
Copper	Dissolved	mg/L	<0.005	0.002	<0.005	0.001
Lead	Dissolved	mg/L	<0.0005	<0.0002	<0.0005	0.0001
Lithium	Dissolved	mg/L	0.677	0.336	0.647	0.001
Molybdenum	Dissolved	mg/L	<0.005	<0.002	<0.005	0.001
Nickel	Dissolved	mg/L	0.013	0.018	0.047	0.0005
Selenium	Dissolved	mg/L	<0.001	<0.0004	<0.001	0.0002
Silver	Dissolved	mg/L	<0.00005	<0.00002	<0.00005	0.00001
Strontium	Dissolved	mg/L	4.05	3.49	5.68	0.001
Thallium	Dissolved	mg/L	<0.0003	<0.0001	<0.0003	0.00005
Tin	Dissolved	mg/L	<0.005	<0.002	<0.005	0.001
Titanium	Dissolved	mg/L	<0.002	<0.001	<0.002	0.0005
Uranium	Dissolved	mg/L	0.026	0.0360	0.0862	0.0005
Vanadium	Dissolved	mg/L	<0.0005	0.0006	<0.0005	0.0001
Zinc	Dissolved	mg/L	<0.005	0.006	<0.005	0.001
Subsample	Field Filtered		Lab Filtered	Lab Filtered	Lab Filtered	
Microbiological Analysis						
Total Coliforms	Membrane Filtration	CFU/100 mL	1	<1	<1	1
Fecal Coliforms	Membrane Filtration	CFU/100 mL	<1	<1	<1	1
Routine Water						
pH			7.74	7.17	7.18	
Temperature of observed pH		°C	22.0	22.3	22.6	
Electrical Conductivity	at 25 °C	µS/cm	5560	3230	6040	1



## Analytical Report

Bill To: Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5 Attn: Milan Butorac Sampled By: Milan Butorac Company: Thurber Engineering Ltd.	Project ID: 16080 Project Name: Bawlf Project Location: LSD: P.O.: 16080 Proj. Acct. code:	Lot ID: <b>1240624</b> Control Number: C110307 Date Received: Nov 21, 2017 Date Reported: Nov 27, 2017 Report Number: 2245158
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------

		Reference Number	1240624-1	1240624-2	1240624-3	
		Sample Date	Nov 21, 2017	Nov 21, 2017	Nov 21, 2017	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH15-1 / 0.1°C	TH15-2 / 0.1°C	TH15-3 / 0.1°C	
		Matrix	Water	Water	Water	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
<b>Routine Water - Continued</b>						
Calcium	Dissolved	mg/L	408	449	755	0.2
Magnesium	Dissolved	mg/L	137	119	226	0.2
Sodium	Dissolved	mg/L	1010	288	815	0.4
Potassium	Dissolved	mg/L	15	13	14	0.4
Iron	Dissolved	mg/L	<0.05	0.07	0.2	0.01
Manganese	Dissolved	mg/L	1.20	1.89	2.77	0.005
Chloride	Dissolved	mg/L	19.3	46.0	113	0.4
Nitrate - N		mg/L	0.08	0.06	<0.05	0.01
Nitrite - N		mg/L	<0.02	<0.02	<0.02	0.005
Nitrate and Nitrite - N		mg/L	0.08	0.06	<0.07	0.01
Sulfate (SO4)	Dissolved	mg/L	3170	1240	2890	0.9
Hydroxide		mg/L	<5	<5	<5	
Carbonate		mg/L	<6	<6	<6	
Bicarbonate		mg/L	529	1010	1630	
P-Alkalinity	as CaCO3	mg/L	<5.0	<5.0	<5.0	5
T-Alkalinity	as CaCO3	mg/L	433	830	1330	5
Total Dissolved Solids	Calculated	mg/L	5020	2660	5610	1
Hardness	Dissolved as CaCO3	mg/L	1580	1610	2810	
Ionic Balance	Dissolved	%	101	103	102	



## Analytical Report

Bill To: Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5 Attn: Milan Butorac Sampled By: Milan Butorac Company: Thurber Engineering Ltd.	Project ID: 16080 Project Name: Bawlf Project Location: LSD: P.O.: 16080 Proj. Acct. code:	Lot ID: <b>1240624</b> Control Number: C110307 Date Received: Nov 21, 2017 Date Reported: Nov 27, 2017 Report Number: 2245158
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------

		Reference Number	1240624-4	1240624-5	1240624-6	
		Sample Date	Nov 21, 2017	Nov 21, 2017	Nov 21, 2017	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH15-4 / 0.1°C	TH15-5 / 0.1°C	TH15-5Dupl. / 0.1°C	
		Matrix	Water	Water	Water	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
<b>Aggregate Organic Constituents</b>						
Chemical Oxygen Demand		mg/L	26	34	40	5
<b>Inorganic Nonmetallic Parameters</b>						
Kjeldahl Nitrogen	Total	mg/L	0.95	0.42	1.94	0.07
<b>Metals Dissolved</b>						
Silicon	Dissolved	mg/L	10.3	9.31	9.35	0.05
Sulfur	Dissolved	mg/L	481	1750	1780	0.3
Aluminum	Dissolved	mg/L	<0.004	<0.010	<0.010	0.002
Antimony	Dissolved	mg/L	<0.0004	<0.001	<0.001	0.0002
Arsenic	Dissolved	mg/L	0.0078	0.002	0.004	0.0002
Barium	Dissolved	mg/L	0.036	0.007	0.006	0.001
Beryllium	Dissolved	mg/L	<0.0002	<0.0005	<0.0005	0.0001
Bismuth	Dissolved	mg/L	<0.001	<0.002	<0.002	0.0005
Boron	Dissolved	mg/L	0.393	0.618	0.614	0.002
Cadmium	Dissolved	mg/L	0.00002	0.00008	<0.00005	0.00001
Chromium	Dissolved	mg/L	<0.001	<0.002	<0.002	0.0005
Cobalt	Dissolved	mg/L	0.0076	<0.0005	<0.0005	0.0001
Copper	Dissolved	mg/L	<0.002	<0.005	<0.005	0.001
Lead	Dissolved	mg/L	<0.0002	<0.0005	<0.0005	0.0001
Lithium	Dissolved	mg/L	0.382	0.749	0.760	0.001
Molybdenum	Dissolved	mg/L	<0.002	<0.005	<0.005	0.001
Nickel	Dissolved	mg/L	0.0068	0.004	0.0074	0.0005
Selenium	Dissolved	mg/L	<0.0004	<0.001	<0.001	0.0002
Silver	Dissolved	mg/L	<0.00002	<0.00005	<0.00005	0.00001
Strontium	Dissolved	mg/L	2.53	7.14	7.33	0.001
Thallium	Dissolved	mg/L	<0.0001	<0.0003	<0.0003	0.00005
Tin	Dissolved	mg/L	<0.002	<0.005	<0.005	0.001
Titanium	Dissolved	mg/L	<0.001	<0.002	<0.002	0.0005
Uranium	Dissolved	mg/L	0.0046	0.004	0.004	0.0005
Vanadium	Dissolved	mg/L	<0.0002	<0.0005	<0.0005	0.0001
Zinc	Dissolved	mg/L	0.004	0.023	0.013	0.001
Subsample	Field Filtered		Lab Filtered	Lab Filtered	Lab Filtered	
<b>Microbiological Analysis</b>						
Total Coliforms	Membrane Filtration	CFU/100 mL	<1	<1	<1	1
Fecal Coliforms	Membrane Filtration	CFU/100 mL	<1	<1	<1	1
<b>Routine Water</b>						
pH			7.58	7.97	7.62	
Temperature of observed pH		°C	22.5	22.4	22.4	
Electrical Conductivity	at 25 °C	µS/cm	3370	9110	9120	1



## Analytical Report

Bill To: Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5 Attn: Milan Butorac Sampled By: Milan Butorac Company: Thurber Engineering Ltd.	Project ID: 16080 Project Name: Bawlf Project Location: LSD: P.O.: 16080 Proj. Acct. code:	Lot ID: <b>1240624</b> Control Number: C110307 Date Received: Nov 21, 2017 Date Reported: Nov 27, 2017 Report Number: 2245158
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------

		Reference Number	1240624-4	1240624-5	1240624-6	
		Sample Date	Nov 21, 2017	Nov 21, 2017	Nov 21, 2017	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH15-4 / 0.1°C	TH15-5 / 0.1°C	TH15-5Dupl. / 0.1°C	
		Matrix	Water	Water	Water	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
<b>Routine Water - Continued</b>						
Calcium	Dissolved	mg/L	250	456	464	0.2
Magnesium	Dissolved	mg/L	67.1	144	147	0.2
Sodium	Dissolved	mg/L	540	1970	1990	0.4
Potassium	Dissolved	mg/L	18	19	20	0.4
Iron	Dissolved	mg/L	0.25	<0.05	0.07	0.01
Manganese	Dissolved	mg/L	1.56	0.29	0.30	0.005
Chloride	Dissolved	mg/L	13.1	9	38	0.4
Nitrate - N		mg/L	<0.05	1.91	1.04	0.01
Nitrite - N		mg/L	<0.02	<0.05	<0.05	0.005
Nitrate and Nitrite - N		mg/L	<0.07	1.91	1.04	0.01
Sulfate (SO4)	Dissolved	mg/L	1440	5240	5340	0.9
Hydroxide		mg/L	<5	<5	<5	
Carbonate		mg/L	<6	<6	<6	
Bicarbonate		mg/L	709	630	658	
P-Alkalinity	as CaCO3	mg/L	<5.0	<5.0	<5.0	5
T-Alkalinity	as CaCO3	mg/L	582	516	539	5
Total Dissolved Solids	Calculated	mg/L	2680	8150	8320	1
Hardness	Dissolved as CaCO3	mg/L	899	1730	1760	
Ionic Balance	Dissolved	%	100	101	100	

Approved by: 

Anthony Neumann, MSc  
Laboratory Operations Manager

Data have been validated by Analytical Quality Control and Exova's Integrated Data Validation System (IDVS).

Generation and distribution of the report, and approval by the digitized signature above, are performed through a secure and controlled automatic process.



## Methodology and Notes

Bill To: Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID: 16080 Project Name: Bawlf Project Location: LSD: P.O.: 16080 Proj. Acct. code:	Lot ID: <b>1240624</b> Control Number: C110307 Date Received: Nov 21, 2017 Date Reported: Nov 27, 2017 Report Number: 2245158
Attn: Milan Butorac Sampled By: Milan Butorac Company: Thurber Engineering Ltd.		

## Method of Analysis

Method Name	Reference	Method	Date Analysis Started	Location
Alkalinity, pH, and EC in water	APHA	* Alkalinity - Titration Method, 2320 B	Nov 22, 2017	Exova Edmonton
Alkalinity, pH, and EC in water	APHA	* Conductivity, 2510 B	Nov 22, 2017	Exova Edmonton
Alkalinity, pH, and EC in water	APHA	* pH - Electrometric Method, 4500-H+ B	Nov 22, 2017	Exova Edmonton
Anions (Routine) by Ion Chromatography	APHA	* Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	Nov 23, 2017	Exova Edmonton
Approval-Edmonton	APHA	Checking Correctness of Analyses, 1030 E	Nov 23, 2017	Exova Edmonton
Chemical Oxygen Demand in water	APHA	* Closed Reflux, Colorimetric Method, 5220 D	Nov 22, 2017	Exova Edmonton
Chloride in Water	APHA	* Automated Ferricyanide Method, 4500-Cl-E	Nov 22, 2017	Exova Edmonton
Coliforms - Membrane Filtration	APHA	Fecal Coliform Membrane Filter Procedure, 9222 D	Nov 22, 2017	Exova Calgary
Coliforms - Membrane Filtration	APHA	Standard Total Coliform Membrane Filter Procedure, 9222 B	Nov 22, 2017	Exova Calgary
Metals ICP-MS (Dissolved) in water	US EPA	* Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	Nov 23, 2017	Exova Edmonton
Metals Trace (Dissolved) in water	APHA	Hardness by Calculation, 2340 B	Nov 23, 2017	Exova Edmonton
Metals Trace (Dissolved) in water	APHA	* Inductively Coupled Plasma (ICP) Method, 3120 B	Nov 23, 2017	Exova Edmonton
Total and Kjeldahl Nitrogen (Total) in Water	ISO	* Water Quality - Determination of nitrogen, ISO/TR 11905-2	Nov 22, 2017	Exova Edmonton

\* Reference Method Modified

## References

APHA	Standard Methods for the Examination of Water and Wastewater
APHA/USEPA	Standard Methods For Water/ Environmental Protection Agency
ISO	International Organization for Standardization
US EPA	US Environmental Protection Agency Test Methods

Please direct any inquiries regarding this report to our Client Services Group or to the Operations Manager at the coordinates indicated at the top left of this page.

Results relate only to samples as submitted.

The test report shall not be reproduced except in full, without the written approval of the laboratory.



